

**Gravitational Forces
U3004504 / Version 1
02 Dec 2004**

SECTION I. ADMINISTRATIVE DATA

All Courses Including This Lesson	<u>Course Number</u>	<u>Version</u>	<u>Course Title</u>
	300-F6	2005	Flight Medic
	6A-61N9D	05	Flight Surgeon Course (Primary)
	6A-61N9D(RC)(P1)	05	Flight Surgeon Course (Primary), Phase I
	6H-F27	04D	AEROMEDICAL PSYCHOLOGY TRAINING

Task(s) Taught(*) or Supported	<u>Task Number</u>	<u>Task Title</u>
		<u>INDIVIDUAL</u>
	081-CF9-0005 (*)	MANNAGE THE EFFECTS OF ACCELERATION AND GRAVITY DURING FLIGHT

Reinforced Task(s)	<u>Task Number</u>	<u>Task Title</u>

Academic Hours	The academic hours required to teach this lesson are as follows:		
		<u>Resident Hours/Methods</u>	
		1 hr	/ Conference / Discussion
	Test	0 hrs	
	Test Review	0 hrs	
	Total Hours:	1 hr	

Test Lesson Number	<u>Hours</u>	<u>Lesson No.</u>
Testing (to include test review)	1 hr	U3004503 version 1

Prerequisite Lesson(s)	<u>Lesson Number</u>	<u>Lesson Title</u>
	None	

Clearance Access	Security Level: Unclassified Requirements: There are no clearance or access requirements for the lesson.
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Foreign Disclosure Restrictions	FD5. This product/publication has been reviewed by the product developers in coordination with the USASAM foreign disclosure authority. This product is releasable to students from all requesting foreign countries without restrictions.
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References

<u>Number</u>	<u>Title</u>	<u>Date</u>	<u>Additional Information</u>
0-7817-2898-3	Fundamental of Aerospace Medicine, 3rd Edition		
FM 3-04.301	Aeromedical Training for Flight Personnel	29 Sep 2000	

Student Study Assignments

Study SH and review reference material listed above.

Instructor Requirements

One instructor. Must be a 91W3F, 91W4F, or a 67J MSC Officer. Must have attended the Instructor Training Course.

Additional Support Personnel Requirements

<u>Name</u>	<u>Stu Ratio</u>	<u>Qty</u>	<u>Man Hours</u>
None			

Equipment Required

<u>Id Name</u>	<u>Stu Ratio</u>	<u>Instr Ratio</u>	<u>Spt</u>	<u>Qty</u>	<u>Exp</u>
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for Instruction

COMPU-PR0J OVERHEAD PROJECTOR W/ COMPUTER INTERFACE	1:50		No	0	No
COMPUTER-INSTRUCTOR COMPUTER (CPU) WITH KEYBOARD, INSTRUCTOR USE ONLY	1:50		No	0	No
MONITOR-INSTRUCTOR COMPUTER MONITOR, INSTRUCTOR USE ONLY	1:50		No	0	No
SCREEN-INSTRUCTOR SCREEN PROJECTOR, INSTRUCTOR USE	1:50		No	0	No

* Before Id indicates a TADSS

Materials Required**Instructor Materials:**

Lesson plan, Student handout, Computer Workstation, and Overhead projector.

Student Materials:

Student handout.

Classroom, Training Area, and Range Requirements

**Ammunition
Requirements**

<u>Id</u>	<u>Name</u>	<u>Exp</u>	<u>Stu Ratio</u>	<u>Instr Ratio</u>	<u>Spt Qty</u>
None					

**Instructional
Guidance**

NOTE: Before presenting this lesson, instructors must thoroughly prepare by studying this lesson and identified reference material.

Instruct the class from the Lesson Plan, Power Point Presentation. Answer all student questions.

**Proponent
Lesson Plan
Approvals**

<u>Name</u>	<u>Rank</u>	<u>Position</u>	<u>Date</u>
Campbell, John			09 Dec 2004
Schwab, Douglas			02 Dec 2004
Bost-Pittman, Carolyn			03 Dec 2004

SECTION II. INTRODUCTION

Method of Instruction: <u>Conference / Discussion</u>
Instructor to Student Ratio is: <u>1:50</u>
Time of Instruction: <u>5 mins</u>
Media: <u>Large Group Instruction</u>

Motivator

“Aircrew members must understand gravitational forces (g-force) and the body’s physiological responses to them. They must understand the physics of motion and accelerative forces, their influences and effects, which will be discussed. We will also discuss deceleration and more importantly, the crash sequence and how aircraft design features offer protection from crash forces. Knowledge and understanding of this information could greatly enhance your survivability during crash sequence.”

Terminal Learning Objective

NOTE: Inform the students of the following Terminal Learning Objective requirements.

At the completion of this lesson, you [the student] will:

Action:	Manage the effects of Graviational Forces.
Conditions:	In a classroom environment
Standards:	In accordance with (IAW) FM 3-04.-301 and Fundamentals of Aerospace Medicine.

Safety Requirements

None.

Risk Assessment Level

Low - Low

Environmental Considerations

None **NOTE:** It is the responsibility of all soldiers and DA civilians to protect the environment from damage.

Evaluation

NOTE: IERW, FMAC, AFSPC.

On the last day of aviation medicine academics, each student will be evaluated on this block with a 50 question examination in which they must answer 35 of 50 questions correctly to receive a passing score. The test will be given in room X110 of Bldg 301.

NOTE: All other courses.

On the last day of aviation medicine academics, each student will be evaluated on this block with a 40 question examination in which they

must answer 28 of 40 questions correctly to receive a passing score. The test will be given in Bldg 301.

**Instructional
Lead-In**

Instructor may use his/her own words for instructional Lead-in.

SECTION III. PRESENTATION

NOTE: Inform the students of the Enabling Learning Objective requirements.

A. ENABLING LEARNING OBJECTIVE

ACTION:	Define gravitational force terms.
CONDITIONS:	Define gravitational forces terminology
STANDARDS:	IAW FM 3-04.301 and Fundamentals of Aerospace Medicine.

1. Learning Step / Activity 1. Define Gravitational Force terminology.

Method of Instruction: Conference / Discussion

Instructor to Student Ratio: 1:50

Time of Instruction: 5 mins

Media: Large Group Instruction

- a. "G" is the measure of the magnitude of an accelerative force with respect to gravity.
 - (1) Equal to 32.2 feet per second squared.
 - (2) Acceleration continues until terminal velocity is reached.
- b. Acceleration is the rate of change of velocity with respect to time.
- c. Deceleration (negative acceleration) is a reduction in the velocity of a moving body with respect to time.
- d. Inertia is the resistance to a change in the state of rest or motion.
 - (1) A body in motion tends to stay in motion, unless acted on by an outside force.
 - (2) A body at rest tends to stay at rest, unless acted on by an outside force.
- e. The tri-axial reference system identifies the direction in which the body receives accelerative forces.

NOTE: Note: Conduct a check on learning now, or wait until the summary

CHECK ON LEARNING: Conduct a check on learning and summarize the learning step/activity.

B. ENABLING LEARNING OBJECTIVE

ACTION:	Recognize the factors of acceleration with their appropriate effects.
CONDITIONS:	Given a list of factors and effects.
STANDARDS:	IAW FM 3-04.301 and Fundamentals of Aerospace Medicine.

1. Learning Step / Activity 1. Provide instruction on the factors and effects of acceleration.

Method of Instruction: Conference / Discussion
Instructor to Student Ratio: 1:50
Time of Instruction: 5 mins
Media: Large Group Instruction

Factors of acceleration.

a. Intensity--the greater the intensity, the more severe the effects of accelerative forces. (Intensity, however, is closely related to duration)

b. Duration--the longer the force is applied, the more severe the effects.

(1) Ejection seat sequences expose the aviator to approximately 15g's for about 0.1 seconds without difficulties. If this intensity was lengthen to 2 seconds the aviator would be rendered unconsciousness.

(2) There will be 2 to 3 minute state of unusable consciousness after normal blood pressure is returned.

c. Rate of onset--the faster the rate of acceleration, the more severe the effects.

d. Body area and site--the greater the size of the body area affected, the less severe the effects.

e. Impact direction--a force in the Gy axis will not be tolerated as well as a force applied to another axis because of aircraft structural and human physiological limitations.

CHECK ON LEARNING: Conduct a check on learning and summarize the learning step/activity.

C. ENABLING LEARNING OBJECTIVE

ACTION:	Identify the effects of low magnitude acceleration.
CONDITIONS:	Given a list.
STANDARDS:	IAW FM 3-04.301 and Fundamentals of Aerospace Medicine..

1. Learning Step / Activity 1. Provide instruction of the physiologic effects of low magnitude acceleration.

Method of Instruction: Conference / Discussion
Instructor to Student Ratio: 1:50
Time of Instruction: 10 mins
Media: Large Group Instruction

REMINDER: Low magnitude accelerations are described as “G”s that range from 1 to 10 “G”s lasting for several seconds.

a. +Gz--during a +Gz maneuver, body weight increases in direct proportion to the force (200 pounds will weigh 600 pounds during a 3G maneuver).

(1) Circulatory effects.

(a) Blood pooling in the lower extremities.

(b) As the force exceeds 2G's, blood flow to the eye decreases causing a gradual loss of peripheral vision (grayout).

(2) +Gz tolerance limits.

(a) 1.0-2.5 Gz: Blood pooling.

(b) 2.5-4.0 Gz: Grayout.

(c) 4.0-4.5 Gz: Blackout.

(d) 4.5 and above: Unconsciousness.

(3). Factors that modify +Gz tolerance.

(a) Decremental factors are any factors that reduce the overall efficiency of the body, especially the circulatory system.

(b) Blood volume decrease.

1. Dehydration.

2. Hemorrhage.

3. Acute alcohol abuse.

4 Varicose veins.

(c) Blood pressure decrease.

1 Due to blood loss or dehydration.

2 Illness/not physically fit.

3 Acute alcohol abuse.

(4) Incremental factors are any factors that enhance the ability of the body to withstand G-forces.

(a) Hypertension.

(b) Fear/excitement.

(c) Tensing of muscles.

(d) Short stocky build.

(e) L-1 maneuver.

(f) Anti-G suit.

NOTE: Play video "Centrifuge ride".

b. -Gz circulatory effects.

(a) Result in inadequate circulation to sustain consciousness.
Blood pooling and stagnation occur in the head and neck.

(b) A rise in intracranial pressure produces head pain and visual disturbances.

c. -Gz tolerance limits.

(a) 0.0 to -1.0 Blood pooling.

(b) -1.0 to -2.5 Vision affected.

(c) -2.5 to -3.0 Redout.

(d) Over -3.0 Incapacitation.

d. Positive and negative Gx effects.

(a) Aircrew members experience mild transverse accelerations and decelerations when taking off and landing.

(b) Individuals are more tolerant of forces on the Gx axis because transverse G's interfere very little with blood flow.

(c) Tolerance limits.

1. Greater than +7 or -7 G's breathing may become more difficult.

2. Some individuals have withstood up to +20 and -20 G's for several seconds without any severe effects.

e. Gy effects.

(1) Aircraft are structurally designed to handle aerodynamic loads which are transmitted to aircraft occupants primarily in the Gx or Gz axis.

(2) This creates a structural design limitation which makes lateral accelerations (Gy axis) the most lethal to aircraft and occupants.

CHECK ON LEARNING: Conduct a check on learning and summarize the learning step/activity.

D. ENABLING LEARNING OBJECTIVE

ACTION:	Identify the physiological effects of high magnitude acceleration/deceleration.
CONDITIONS:	Given a list.
STANDARDS:	IAW FM 3-04.301 and Fundamentals of Aerospace Medicine.

1. Learning Step / Activity 1. Provide instruction on the physiological effects of high magnitude accelerations/decelerations.

Method of Instruction: Conference / Discussion

Instructor to Student Ratio: 1:50

Time of Instruction: 10 mins

Media: Large Group Instruction

REMINDER: High magnitude accelerations/decelerations are described as G-forces exceeding 10 G's and lasting less than a second.

a. Physiological effects.

(1) Minor discomfort.

(2) Minor injury.

(3) Incapacitation.

(4) Irreversible injury.

(5) Lethal injury.

b. The primary source of high magnitude accelerations and decelerations are aircraft crashes. Additional sources would be ejection seats and parachuting.

CHECK ON LEARNING: Conduct a check on learning and summarize the learning step/activity.

E. ENABLING LEARNING OBJECTIVE

ACTION:	Recognize aircrew member survivability criteria.
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CONDITIONS:	Given a list.
STANDARDS:	IAW FM 3-04.301 and Fundamentals of Aerospace Medicine.

1. Learning Step / Activity 1. Provide instruction on aircrew member survivability criteria.

Method of Instruction: Conference / Discussion
Instructor to Student Ratio: 1:50
Time of Instruction: 10 mins
Media: Large Group Instruction

REMINDER: Occupant survivability during the accident sequence is contingent upon the following criteria:

- a. Amount of crash forces transmitted.

NOTE: Human tolerances:

- 1) +Gx: 80.
- 2) -Gx: 40.
- 3) Gy axis limit is 9.
- 4) +Gz: +20.
- 5) -Gz: -16.

- b. Occupiable living space. Two objects cannot occupy the same space.

- c. Aircraft design features that enhance crash survivability, (CREEP)..

- (1) Container.

- (a) Acts as an effective protective shell.
- (b) Crushable material to attenuate crash forces.

- (2) Restraint system.

- (a) Should be comfortable and snug.
- (b) Should adequately restrain major body parts.

- (3) Environment, make the cockpit less dangerous.

- (4) Energy absorption.

- (a) Landing gear.
- (b) Aircraft undercarriage.
- (c) Seats stroking (approximately 4g's) in newer rotary wing aircraft.

(5) Post crash factors.

(a) Fire.

(2) Evacuation.

CHECK ON LEARNING: Conduct a check on learning and summarize the learning step/activity.

SECTION IV. SUMMARY

Method of Instruction: <u>Conference / Discussion</u>
Instructor to Student Ratio is: <u>1:50</u>
Time of Instruction: <u>5 mins</u>
Media: <u>Large Group Instruction</u>

Check on Learning

- a. Solicit student questions and explanations.
- b. Questions and answers.

QUESTION: Select the term that describes the direction that the body receives accelerative forces.

ANSWER: Tri-Axial reference system.

QUESTION: Intensity is closely related to which other factor of acceleration?

ANSWER: Duration.

QUESTION: Select a factor that increases positive Gz tolerance.

ANSWER: Tensing of muscles.

QUESTION: Select the definition of high magnitude accelerations.

ANSWER: Exceeding 10 G's for less than a second.

QUESTION: Select the items that are aircraft occupant survivability criteria.

ANSWER: Amount of crash forces transmitted, occupiable living space, aircraft design features.

QUESTION: Select the acronym that describes aircraft design features. That enhances crash survivability.

ANSWER: CREEP.

- c. Correct any misunderstandings.

TRANSITION TO THE NEXT LESSON. FILL WITH YOUR OWN TRANSITION.

Review / Summarize Lesson

During the past 50 minutes we have discussed managing the effects of gravitational forces, gravitational terms/definitions, factors of acceleration with their appropriate effects, identified effects of low magnitude acceleration, identified effects of high magnitude acceleration, and aircrewmember survivability criteria.

SECTION V. STUDENT EVALUATION

Testing Requirements

NOTE: Describe how the student must demonstrate accomplishment of the TLO. Refer student to the Student Evaluation Plan.

NOTE: IERW, FMAC, AFSPC.

On the last day of aviation medicine academics, each student will be evaluated with questions from this block on exam #

NOTE: All other courses.

On the last day of aviation medicine academics, each student will be evaluated with questions from this block on exam #

Feedback Requirements

NOTE: Feedback is essential to effective learning. Schedule and provide feedback on the evaluation and any information to help answer students' questions about the test. Provide remedial training as needed.

Ensure that the students fill out end of course critique, also filling in the critique for the exam.

Appendix A - Viewgraph Masters (N/A)

Appendix B - Test(s) and Test Solution(s) (N/A)

Appendix C - Practical Exercises and Solutions (N/A)

Appendix D - Student Handouts (N/A)